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(54) **METHOD AND SYSTEM FOR RETRIEVING A PACKAGE DELIVERED BY AN UNMANNED AERIAL VEHICLE**

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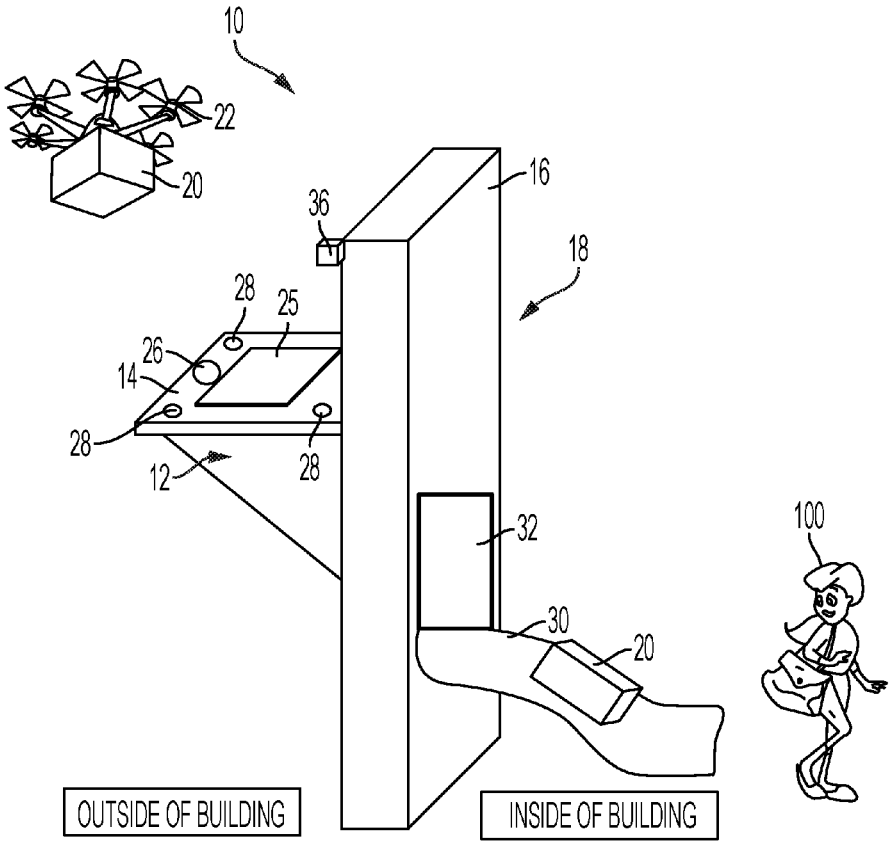
(57) **ABSTRACT**

A system and a method for retrieving a package delivered by an Unmanned Aerial Vehicle (UAV). The system includes a receiving structure mounted to and extending from a wall of a building, the receiving structure being configured to receive the package delivered by the UAV; and a transport system configured to transport the package from the receiving structure located outside of the building to a location inside of the building. The receiving structure includes a platform configured to support a weight of the UAV and the package carried by the UAV, and a trap door mounted to the platform configured to open and close an opening leading to the transport system.



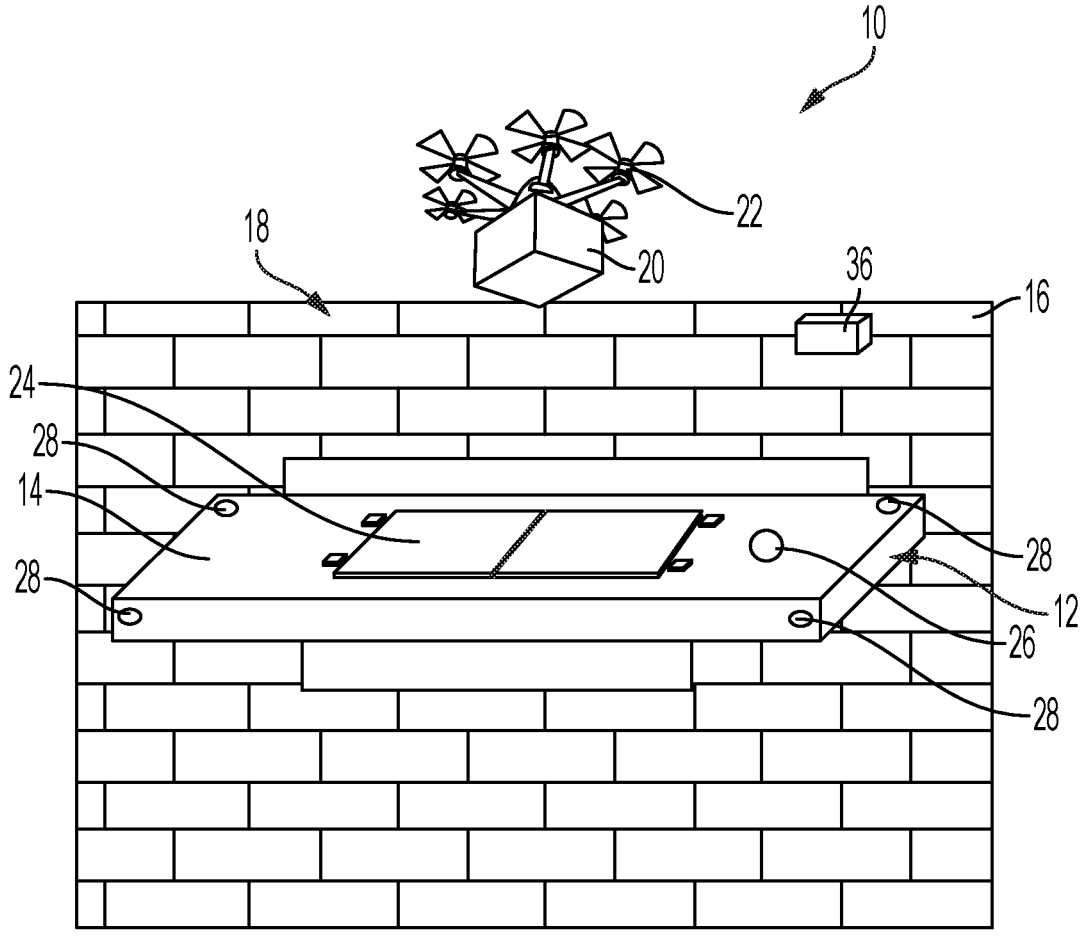


FIG. 1A

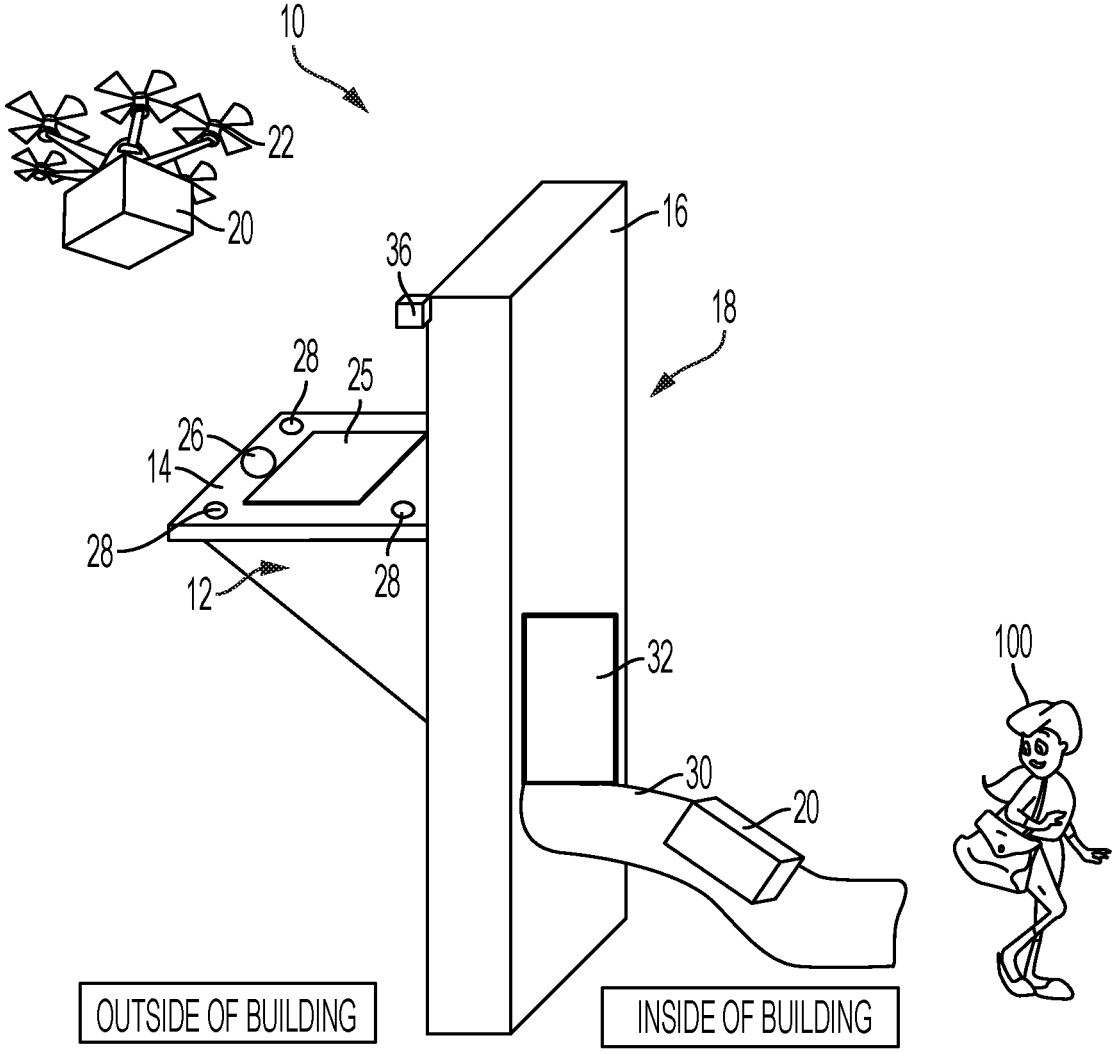

10
22
20
16
36
18
28
25
26
14
28
28
12
32
100
30
20
OUTSIDE OF BUILDING
INSIDE OF BUILDING

FIG. 1B

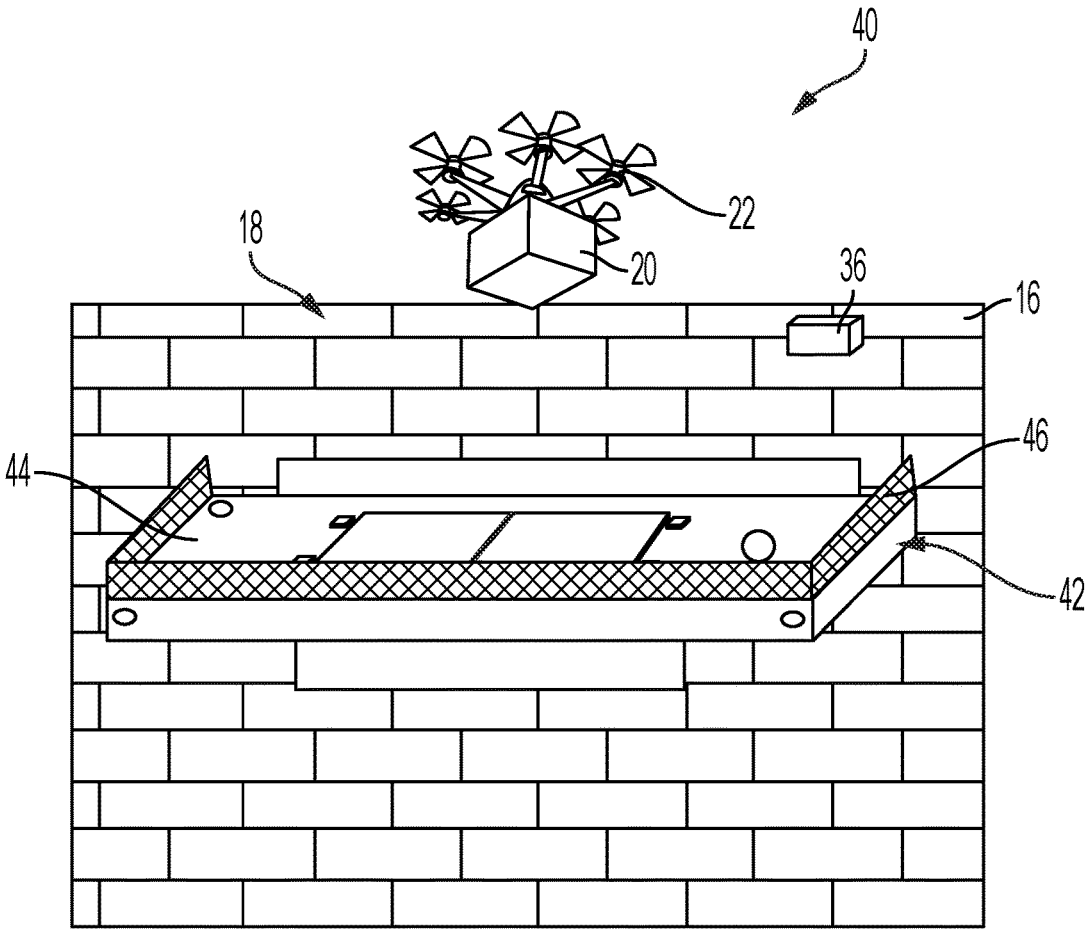


FIG. 2

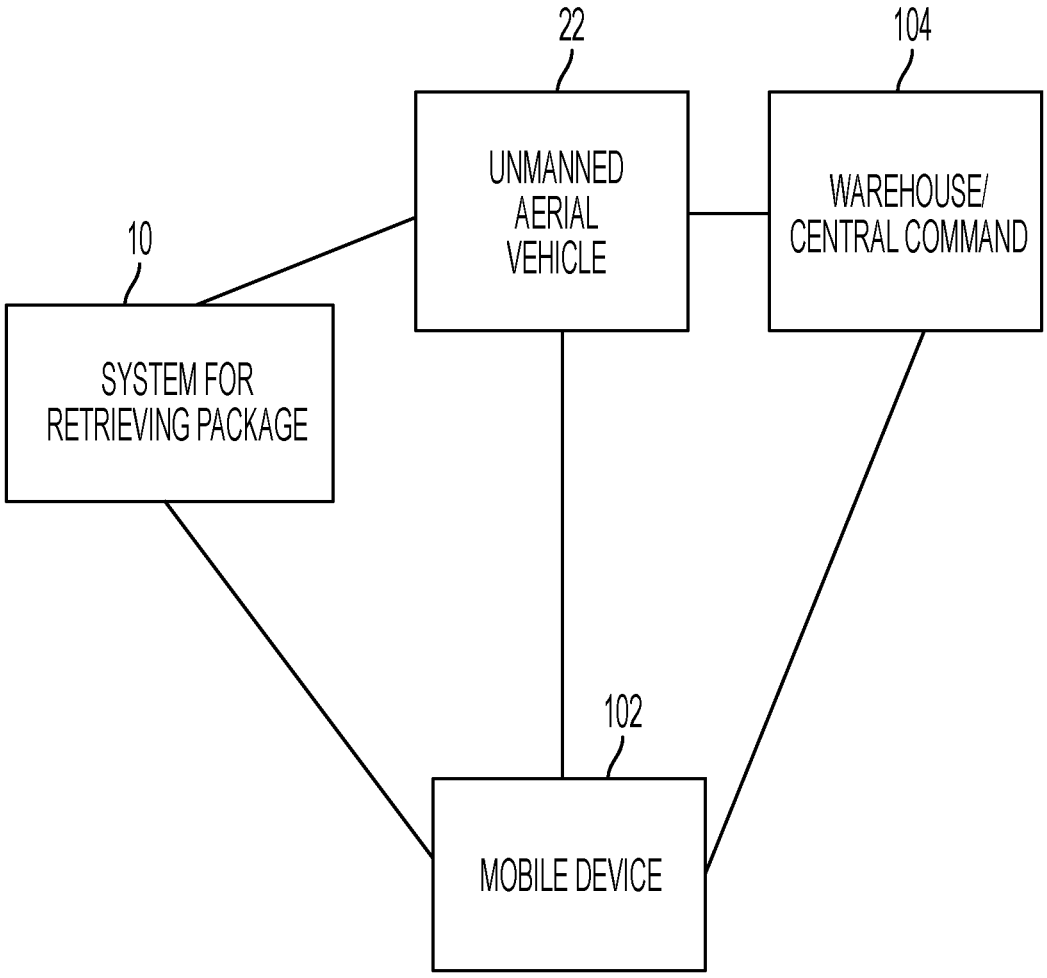

22
104
UNMANNED AERIAL VEHICLE
WAREHOUSE/ CENTRAL COMMAND
10
SYSTEM FOR RETRIEVING PACKAGE
102
MOBILE DEVICE

FIG. 3

METHOD AND SYSTEM FOR RETRIEVING A PACKAGE DELIVERED BY AN UNMANNED AERIAL VEHICLE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present patent application claims priority benefit to U.S. Provisional Patent Application No. 62/649,961 filed on Mar. 29, 2018, the entire content of which is incorporated herein by reference.

BACKGROUND

1. Technical Field

[0002] The present disclosure relates generally to unmanned vehicles transport and more specifically to a method and system for retrieving a package delivered by an unmanned aerial vehicle (UAV).

2. Introduction

[0003] Autonomous vehicles, such as Unmanned Aerial Vehicles (UAVs), commonly known as drones, are becoming ubiquitous. UAVs are increasingly used in aerial imagery and photography, for surveillance, commercial applications, real-estate applications, scientific applications, equipment inspections, agricultural applications, military applications, and recreational applications. UAVs are also contemplated as transport vehicles for delivering goods such as packages. An UAV is an aircraft that is piloted without a human pilot aboard the aircraft. The UAV can be operated using a remote control device by a human operator. The UAV can also be operated autonomously by an onboard programmed or programmable computer(s) programmed to execute a specific series of commands or instructions to control the UAV.

[0004] It is desirable to be able to deliver goods (e.g., one or more packages) using a UAV to a building for subsequent retrieval by a person in the building. However, the current methods or systems to retrieve a package delivered by a UAV have inadequacies.

[0005] Therefore, there remains a need for a novel system and method for retrieving a package delivered by an UAV to a building (e.g., a house, residential building, office building, or other building).

SUMMARY

[0006] An aspect of the present disclosure is to provide a system for retrieving a package delivered by an Unmanned Aerial Vehicle (UAV). The system includes a receiving structure mounted to and extending from a wall of a building, the receiving structure being configured to receive the package delivered by the UAV; and a transport system configured to transport the package from the receiving structure located outside of the building to a location inside of the building. The receiving structure includes a platform configured to support a weight of the UAV and the package carried by the UAV, and a trap door mounted to the platform configured to open and close an opening leading to the transport system.

[0007] Another aspect of the present disclosure is to provide a method for receiving a package delivered by an Unmanned Aerial Vehicle (UAV). The method includes receiving a package carried and delivered by the UAV on a receiving structure mounted to and extending from a wall of a building, the receiving structure comprising a platform configured to support a weight of the UAV and the package carried by the UAV, and a trap door mounted to the platform configured to open and close an opening leading to a transport system. The method also includes opening the trap door upon sensing by a sensor that the package is deposited on the platform or upon receiving a signal from the UAV to open the trap door; and transporting the package by the transport system from the receiving structure located outside of the building to a location inside of the building.

[0008] Additional features and benefits of the disclosure will be set forth in the description which follows, and in part will be obvious from the description, or can be learned by practice of the herein disclosed principles. The features and benefits of the disclosure can be realized and obtained by means of the instruments and combinations particularly pointed out in the appended claims. These and other features of the disclosure will become more fully apparent from the following description and appended claims, or can be learned by the practice of the principles set forth herein. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only and are not intended as a definition of the limits of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1**A is a schematic front view of a system for retrieving a package delivered by a UAV, according to an embodiment of the present disclosure;

[0010] FIG. **1**B is a schematic lateral view of the system for retrieving the package delivered by the UAV, according to an embodiment of the present disclosure;

[0011] FIG. **2** is a schematic front view of a system for retrieving a package delivered by a UAV, according to another embodiment of the present disclosure; and

[0012] FIG. **3** shows a block diagram of a delivery system including a system for retrieving a package, according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0013] FIG. **1**A is a schematic front view of a system **10** for retrieving a package **20** delivered by an autonomous vehicle, such as a UAV **22**, according to an embodiment of the present disclosure. FIG. **1**B is a schematic lateral view of the system **10** for retrieving the package **20** delivered by the UAV **22**, according to an embodiment of the present disclosure. The system **10** includes a receiving structure **12** having a platform **14**. In an embodiment, as shown in FIGS. **1**A and **1**B, the receiving structure **12** is configured as a shelf that extends or projects substantially horizontally from a vertical wall **16** of a building **18** (a house, a residential building, an office building, a factory building, etc.). The receiving structure **12** is located outside of the building **18**. The receiving structure **12** (e.g., shelf) is configured to receive the package **20** carried and delivered by the UAV **22**. In an embodiment, the receiving structure **12** is a solid structure. For example, the receiving structure **12** can be constructed from any building material, including, but not limited to, concrete, wood, metal, plastic, a composite material, or any combination of these materials.

[0014] In an embodiment, the receiving structure **12** (e.g., shelf) can be further configured (i.e., provided large enough and structurally strong enough) to support a weight of the UAV **22** and package **20** that lands on top of the receiving

structure **12**. The platform **14** of the receiving structure **12** can provide a landing/take-off zone for the UAV **22**. As shown in FIG. **1**B, the system **10** further includes a transport system **30** configured to transport the package **20** from the receiving structure **12** located outside of the building **18** to a location inside of the building **18**. In an embodiment, the UAV **22** can land on the platform **14** of the receiving structure **12** securely as an emergency stop without interfering with regular operations, or as a planned stop to deliver the package **20** to an intended recipient **100** via the transport system **30** connected to the receiving structure **12**. In this way, the UAV **22** carrying the package **20** can land on, take-off from, and/or drop off the package **20** on the platform **14** of the receiving structure **12** safely without imperiling the recipient **100** of the package **20** as the recipient **100** is inside the building **18**.

[0015] In an embodiment, in addition to the platform **14**, the receiving structure **12** also includes a trap door **24** (shown in FIG. **1**A) mounted to the platform **14**. The receiving structure **12** also includes a frame, the frame defining an opening **25** therein (shown in FIG. **1**B). The trap door **24** may be mounted to the frame and/or to the platform **14** of the receiving structure **12**. The trap door **24** is configured to open and close the opening **25** leading to the transport system **30**. For example, the package **20** carried by the UAV **22** can be released onto the trap door **24** that opens to the opening **25** leading to the transport system **30** such as a chute or slide system, a conveyor, an elevator, or an Automatic Guided Vehicle (AGV) system. Although the transport system **30** depicted in FIG. **1**B is a chute or slide system, as it can be appreciated, various other systems, including using an AGV system, an elevator system or a conveyor system can also be used for transporting the package **20** from the platform **14** of the receiving structure **12** to a location inside of the building **18**. For example, after the UAV **22** releases the package **20** on the trap door **24**, sensors provided on the receiving structure **12** can detect the presence of the package **20** and a release mechanism is actuated to open the trap door **24**. This allows the package **20** to fall through the opening **25** into the transport system **30** (e.g., chute, conveyor, elevator, etc.) which carries the package **20** via an opening **32** in the wall **16** to the recipient **100** at a location inside of the building **18**.

[0016] In an embodiment, the trap door **24** can be a hinged door, a sliding door, or any other type of door. For example, FIG. **1**A depicts a hinged door. However, a sliding door or an iris-type door can also be used. The trap door **24** can be spring-loaded or actuated by an actuator or motor. Various types of sensors can be used to detect the presence of package **20** on the platform **14** of the receiving structure **12**. For example weight sensors can be used for detecting the package **20** on the platform **14**. Alternatively or in addition, a camera or optical sensors (e.g., laser beam sensor) can also be used to detect the package **20** on the receiving structure **12**. In the case of optical sensors, one or more lasers can be used to project laser beams onto optical sensors and when the package **20** blocks the laser beam or beams, the presence of the package is detected and the trap door **24** is opened. In another embodiment, the UAV **22** may also communicate with the opening mechanism of the trap door **24** and send a signal to open the trap door **24** automatically upon arrival of the UAV **22** to the receiving structure **12**. In this way, the package **20** can be transported to the interior of the building **18** upon its arrival at the receiving structure **12**. This will prevent the package from being damaged by weather elements, such as rain, snow, etc.

[0017] In an embodiment, the receiving structure **12** may also be provided with one or more light indicators **26** to indicate that the package **20** is delivered. In an embodiment, the platform **14** on the building structure **12** can provide a large visual target to be "seen" by the UAV **22** during flight. However, to aid the UAV **22** in locating the receiving structure **12**, one or more location lights **28** can also be provided. In this way even in less than optimal visibility conditions, the UAV **22** can use its on-board cameras and/or position sensors to locate the lights **28** and thus the platform **14** of the receiving structure **12**. The one or more lights **28** can be blinking lights or steady lights. In another embodiment, one or more frequency beacons (e.g., radiofrequency beacons) can be used instead of or in addition to the one or more lights **28**. A communication signal between the one or more frequency beacons and a sensor on-board of the UAV **22** provide for precise location by the UAV **22** of the platform **14** of the receiving structure **12**.

[0018] In an embodiment, a micro-weather monitoring station **36** can be provided in the vicinity of the receiving structure **12**. For example, the micro-weather monitoring station **36** can be mounted to wall **16** of the building **18**. The micro-weather monitoring station **36** can be configured to monitor weather conditions such as wind or rain fall at or in the vicinity of the receiving structure **12** and provide information on the local weather conditions to an approaching UAV **22**. For example, the micro-weather monitoring station **36** can measure the wind in the vicinity of the receiving structure **12** and if the wind reaches a certain level, the micro-weather monitoring station **36** can send the wind information (strength, orientation, etc.) to the UAV **22**. In this way, the UAV **22** can use this information to perform adequate adjustments to its engines and orientation during its approach phase to the receiving structure **12**. For example, if the wind is strong and does not allow for a safe delivery of the package **20**, the UAV **22** may abort the delivery of the package **20** and pull away from the receiving structure **12** to prevent damage to the UAV **22** and/or its cargo package **20**.

[0019] FIG. **2** is a schematic front view of a system **40** for retrieving a package **20** delivered by a UAV **22**, according to another embodiment of the present disclosure. The system **40** includes a receiving structure **42** having a platform **44**. The system **40** shown in FIG. **2** is similar in many aspects to the system **10** shown in FIGS. **1**A and **1**B. Therefore, similar features will not be further described. The embodiment shown in FIG. **2** contains many of the aspects described above with respect to FIGS. **1**A and **1**B. However, in the system shown in FIG. **2**, the receiving structure **42** instead of being constructed mainly as a solid structure as in the receiving structure **12** in FIGS. **1**A and **1**B, the receiving structure **42** in addition to the solid portion platform **44**, also includes a soft portion **46**. The soft portion **46** may include a net, a canvas, or both. The soft portion **46** can be configured to retain the package **20** and thus prevent the package from potentially falling from the structure **42**. The soft portion **46** can be provided at a periphery of the platform **44** and can be arranged vertically relative the platform **44** (as depicted in FIG. **2**) or horizontally relative to the platform **44**, or any angle therebetween. The soft portion **46** can be

provided with desired dimensions (e.g., width and/or height) so as to retain the package **20** in case the package **20** misses the platform **44**.

[0020] As it can be appreciated from the above paragraphs, there is also provided a method for receiving the package **20** delivered by the Unmanned Aerial Vehicle (UAV) **22**. The method includes receiving the package **20** carried and delivered by the UAV **22** on the receiving structure **12** mounted to and extending from the wall **16** of the building **18**. The receiving structure **12** includes the platform **14** configured to support a weight of the UAV **22** and the package **20** carried by the UAV **22**, and a trap door **25** mounted to the platform **14** configured to open and close the opening **25** leading to the transport system **30**. The method further includes opening the trap door **24** upon sensing by a sensor that the package **20** is deposited on the platform **14** or upon receiving a signal from the UAV to open the trap door, and transporting the package by the transport system **30** from the receiving structure **12** located outside of the building **18** to a location inside of the building **18**.

[0021] FIG. **3** shows a block diagram of a delivery system including system **10** for retrieving package **20**, according to an embodiment of the present disclosure. System **10** and/or associated components of system **10** may communicate with the UAV **22** to receive information on package delivery, receive instructions on deployment, receive instructions of storage, and/or send confirmation of package receipt. The system **10** and/or associated components may further communicate with a consumer's mobile device **102** to receive information on package delivery, receive instructions on deployment, receive instructions of storage, and send confirmation of package receipt. The UAV **22** may communicate with the consumer's mobile device **102** to send or receive information on package delivery, send or receive instructions on deployment, send or receive instructions of storage, and send or receive confirmation of package receipt. The UAV **22** and/or the mobile device **102** may communicate with a warehouse **104** to send or receive information on package delivery, and send or receive confirmation of package receipt. The sensor(s), release device(s), controller(s), communication device(s), and/or motion device(s) of system **10** may send and receive signals with the UAV **22** and the consumer's mobile device **102**.

[0022] In an embodiment, when UAV **22** is scheduled to deliver package **20** to a consumer, the system **10** may be prepared for receiving the package **20** on the receiving structure **12** (shown in FIGS. **1**A, **1**B and **2**). For example, when the UAV **22** is near the delivery location, for example, within about a mile or less of the receiving structure **12**, the UAV **22** may communicate with the system **10** and/or the consumer's mobile device **102**. The UAV **22** may send a signal to the system **10** and/or the consumer's mobile device **102** with instructions to the system **10**, for example, to open the trap door **24**.

[0023] In an embodiment, the UAV **22** may communicate with the system **10** to ensure proper alignment of the package **20** to the receiving structure **12** (e.g., proper alignment of the package **20** with the opening **25** under the trap door **24**). The UAV **22** may also communicate with the system **10** to ensure that no animals (e.g., birds) are located on the receiving structure **12**. The UAV **22** may also receive local weather conditions information from the micro-weather station **36** near the receiving structure **12** so as to prepare to make proper adjustments to its engines and orientation during the UAV **22** approach phase to the receiving structure **12**. Once the package **20** is aligned within the receiving structure **12**, the delivery mechanism of the UAV **22** may lower and release the package onto the receiving structure **12**. In an embodiment, the UAV **22** may land on the receiving structure **12** before releasing the package **20**. In another embodiment, the UAV **22** may simply drop the package **20** on the receiving structure **12** without landing on the receiving structure **12**. The receiving structure **12** may sense the package **20** has been delivered and released from the UAV **22**, for example by sensing an increase in load on the receiving structure **12**, or by using optical or other types of sensors. The system **10** may communicate to the UAV **22** or to the consumer's mobile device **102** confirming package delivery.

[0024] After delivery of the package **20** to the receiving structure **12** and the package **20** is transported by the transport system **30** (shown in FIG. **1**B), the consumer **100** may retrieve the package **20** inside the building **18**. The system **10** of the present disclosure may allow for delivery of packages to tall buildings, such as high-rise buildings and/or medium-rise buildings, etc. The system **10** may include sensors, communication device(s), and/or controller (s) to confirm alignment of the package **20** from the UAV **22** before release of the package **20** by the UAV **22**. This may allow for overhead protection of people or animals located below the receiving structure **12**. For example, the package **20** may be delivered to the receiving structure **12** located high up on the building **18**, thus avoiding the need for the UAV **22** to land on the ground.

[0025] Although the receiving structure **12**, **42** is described in the above paragraphs as being mounted to the wall **16** of the building **18**, as it must be appreciated the receiving structure **12**, **42** can also be provided or mounted on a roof of the building **18**. The roof of the building **18** may be inclined or horizontal. In this case also, the receiving structure **12**, **42** can be configured to operate in a similar fashion as the above receiving structure **12**, **42**. In this case, however, upon releasing the package **20** carried by the UAV **22** on the receiving structure **12**, **42**, the package **20** falls through the opening **25** directly into the transport system **30** (e.g., chute, conveyor, elevator, etc.) at a location inside of the building **18** to be guided to another location inside the building **18** where the user **100** can retrieve the package **20**. For example, the package **20** carried by the UAV **22** can be released onto the trap door **24** that opens to the opening **25** leading to the transport system **30** such as a chute or slide system, a conveyor, an elevator, or an Automatic Guided Vehicle (AGV) system that is located inside the building **18**.

[0026] The various embodiments described above are provided by way of illustration only and should not be construed to limit the scope of the disclosure. Various modifications and changes may be made to the principles described herein without following the example embodiments and applications illustrated and described herein, and without departing from the spirit and scope of the disclosure.

[0027] Although the embodiments of disclosure have been described in detail for the purpose of illustration based on what is currently considered to be the most practical, it is to be understood that such detail is solely for that purpose and that the present disclosure is not limited to the disclosed embodiments, but, on the contrary, is intended to cover modifications and equivalent arrangements that are within the spirit and scope of the appended claims. For example, it

is to be understood that the present disclosure contemplates that, to the extent possible, one or more features of any embodiment can be combined with one or more features of any other embodiment.

We claim:

1. A system for retrieving a package delivered by an Unmanned Aerial Vehicle (UAV), the system comprising:

a receiving structure mounted to and extending from a wall of a building, the receiving structure being configured to receive the package delivered by the UAV;

a transport system configured to transport the package from the receiving structure located outside of the building, via an opening in the wall, to a location inside of the building,

wherein the receiving structure comprises:

a platform having a top surface configured to support a weight of the UAV and the package carried by the UAV, a bottom surface and an exterior frame defining an opening from the top surface through the bottom surface, the opening leading to the transport system and

a trap door mounted to the platform and configured to open and close the opening leading to the transport system

a sensor configured to detect a presence of the package on the platform of the receiving structure; and

a controller coupled to the sensor to receive a signal from the sensor that the package is on the platform, and to send a signal to open the trap door when the signal is received.

2. The system according to claim **1**, further comprising navigation sensors disposed at the receiving structure, the navigation sensors emitting signals indicating a location and identification of the receiving structure.

3. The system according to claim **1**, wherein the transport system comprises a slide, a chute, a conveyor, an elevator, or an automated guided vehicle (AGV) system, or any combination thereof.

4. The system according to claim **1**, wherein the platform is configured and arranged to provide a landing or take-off area to the UAV.

5. The system according to claim **1**, wherein the top surface of the frame is substantially flat and projects substantially horizontally from the wall of the building, and further comprising a barrier extending vertically from and arranged around a periphery of the top surface.

6. The system according to claim **1**, wherein the exterior frame and the wall cooperate to define the opening.

7. The system according to claim **1**, wherein the trap door is spring loaded or actuated by an actuator or motor.

8. The system according to claim **1**, where the transport system comprises one of a slide arranged to receive the package via the trap door, a conveyor arranged to receive the package via the trap door, or an elevator arranged to receive the package via the trap door.

9. The system according to claim **1**, wherein the sensor comprises a weight sensor, a camera, an optical sensor, or any combination thereof.

10. The system according to claim **1**, wherein the receiving structure further comprises light indicators to indicate that the package is delivered.

11. The system according to claim **1**, wherein the receiving structure further comprises one or more location lights, one or more frequency beacons, or both configured to enable the UAV to locate the receiving structure.

12. The system according to claim **1**, further comprising a micro-weather monitoring station provided in the vicinity of the receiving structure, the micro-weather monitoring station being configured to monitor weather conditions at or in the vicinity of the receiving structure and provide information on local weather conditions to an approaching UAV.

13. The system according to claim **1**, wherein the receiving structure comprises a soft portion to retain the package and prevent the package from potentially falling from the receiving structure.

14. The system according to claim **13**, wherein the soft structure, includes a net, or a canvas or both.

15. A method for receiving a package delivered by an Unmanned Aerial Vehicle (UAV), the method comprising:

receiving a package carried and delivered by the UAV on a receiving structure mounted to and extending from a wall of a building, the receiving structure comprising a platform configured to support a weight of the UAV and the package carried by the UAV, and a trap door mounted to the platform configured to open and close an opening leading to a transport system;

opening the trap door upon sensing by a sensor that the package is deposited on the platform or upon receiving a signal from the UAV to open the trap door; and

transporting the package by the transport system from the receiving structure located outside of the building to a location inside of the building.

16. The method according to claim **15**, wherein transporting the package comprises sliding the package though a slide, carrying the package using a conveyor, an elevator or an automated guided vehicle (AGV) system, or any combination thereof to the location inside of the building.

17. The method according to claim **15**, further comprising prior to opening the trap door sensing a weight of the package using a weight sensor or sensing the package using an optical sensor or camera, or both.

18. The method according to claim **15**, further comprising monitoring weather conditions at or in the vicinity of the receiving structure and providing information on local weather conditions to an approaching UAV.

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